NUEXCO

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World Uranium Resources

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World Uranium Resources

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World Uranium Resources

INTRODUCTION

Uranium exploration and development activities have been reviewed by Nuexco with the primary objective of establishing an estimate of uranium resources currently available in the Free World. Nuexco estimates are based on *reasonably assured resources*, which are defined as known quantities of uranium that can be recovered within a given cost range, based upon current mining and milling technology. The cost cutoff used throughout this report is US$50.00 or less per pound U_3O_8.

The definition is broad enough to include all resource estimates based on various geologic, technologic and economic parameters. More importantly, it is consistent with the terminology applied to world resources by the International Atomic Energy Agency (IAEA). It is also equivalent to the term *ore reserves* as reported by the US Department of Energy (USDOE).

The IAEA refers to *estimated additional resources* as all undiscovered uranium expected to occur along well-defined geologic trends containing known deposits, and considered recoverable within the given cost range. Estimated additional resources have not been considered in this report.

The Nuexco estimate of reasonably assured resources, as of November 1, 1980, totals 2,800,000 tonnes U_3O_8, compared to an estimate of 2,590,000 tonnes on June 15, 1979. This represents an increase in reasonably assured resources of 210,000 tonnes U_3O_8[1] above Nuexco's June 15, 1979 estimate.

Most of the increase occurred in South Africa where uranium resources are related to gold reserves in the Witwatersrand district. A significant downward adjustment in Canadian resources was made to correspond with measured and indicated resources calculated by the Canadian Department of Energy, Mines and Resources.

Exploration and development activities have declined in some areas, especially in the US and Niger. The Australian uranium industry is moving ahead with the development of the Nabarlek and Ranger deposits in the Northern Territory. In Canada, exploration is at about the same level as 1979. New projects are limited primarily to northern Saskatchewan.

Activities in other countries are highlighted by the announced discovery of 23,600 tonnes U_3O_8 in France, where an aggressive exploration and development program is on-going. Details on activities in other countries are less well known, although discoveries have been reported in Turkey, Austria and Finland.

[1]The reserve increase of 210,000 tonnes U_3O_8 is a gross amount. 1979 production has not been considered.

AFRICA

Interest in African uranium has led to exploration activities throughout the continent. Known deposits and minor occurrences are found in South Africa, Namibia, Niger, Gabon, Central African Empire, Algeria, Nigeria, Zambia, Somalia and Egypt. Exploration projects are currently under way in Zimbabwe, Mauritania, Mali, Libya, Chad, Zaire, Angola, Tanzania and Kenya. Reasonably assured resources for Africa are approximately 858,500 tonnes U_3O_8. The principal areas of interest are shown in Figure 1.

South Africa

The bulk of South Africa's uranium is produced as a by-product to gold production. Uranium production levels in South Africa are therefore not as sensitive to price as in other uranium producing nations. Uranium production is, in fact, affected more by fluctuations in gold value than uranium value. Reasonably assured resources, as limited to the quartz-pebble conglomerates of the Witwatersrand system, are estimated by the South African Atomic Energy Board at 364,000 tonnes U_3O_8, plus approximately 15,000 tonnes U_3O_8 in mill tailings. Reasonably assured resources known to occur in other rock types are limited to 40,000 tonnes U_3O_8 in sediments of the Karoo Basin, and 3,000 tonnes in the carbonates at Palaborwa. Reasonably assured resources total 152,000 tonnes U_3O_8.

Production capacity is about 13,000 tonnes U_3O_8 per year from 12 uranium production centers in the Witwatersrand district of South Africa, nine of which recover uranium as a by-product of gold mining. The remaining three produce gold and uranium as co-products, i.e. both are necessary for viability. Three additional production centers are under construction —all of which will recover uranium. Uranium is also produced as a byproduct at the Palaborwa copper mines in the northeast region of South Africa.

Uranium production centers in the Witwatersrand district of the Republic of South Africa are listed in Table 1.

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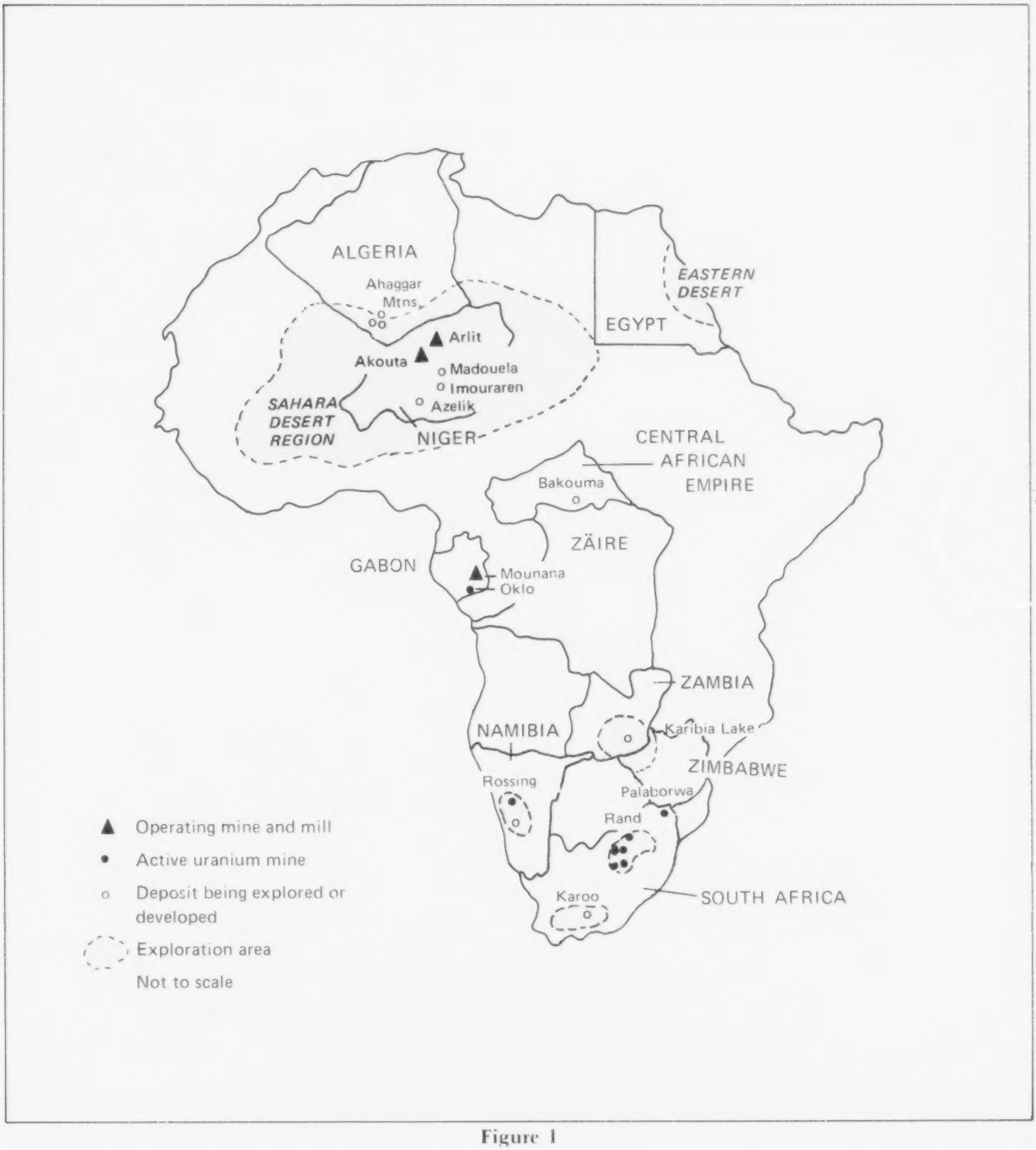

Figure 1
AFRICA

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Table 1

URANIUM PRODUCTION CENTERS OF THE WITWATERSRAND DISTRICT, SOUTH AFRICA

Operating
Randfontein
West Driefontein
Western Deep Levels
Blyvooruitzicht
Chemwes (Stilfontein)
Hartebeestfontein
Buffelsfontein
Vaal Reefs
Joint Metallurgical Scheme
Harmony[2]
West Rand Consolidated[2]
Ergo[2]
Under Construction:
Western Areas
Afrikander Lease[2]
Beisa[2]

[2]Gold and uranium ore coproducts.

Namibia

Exploration and mining activity in Namibia is centered around the Rossing deposit. Mine and mill production is about 5,000 tonnes per year of U_3O_8. Evaluation of the country's other uranium deposits, particularly the Langer Heinrich deposit, is still in progress, but at a reduced level of activity. Reasonably assured resources are estimated at 90,000 tonnes U_3O_8 at the Rossing deposit and about 11,000 tonnes U_3O_8 at the Langer Heinrich deposit.

Niger

The Agadez basin area of Niger has emerged as one of the world's main sources of uranium. The level of exploration has decreased, but production capacity is increasing. Production in 1979 was 4,175 tonnes U_3O_8. Expanded production capacity is under construction. Total capacity in Niger could reach 5,300 tonnes U_3O_8 by 1982 or 1983.

The Arlit deposit, controlled by Societe des Mines de l'Aire (Somair), was the first to be mined in Niger. The ore deposit is in Carboniferous clay and sandstone formations. The average grade of the ore is 0.21 percent U_3O_8.[3] Annual mine and mill production rate is 2,100 tonnes U_3O_8. Production capacity is scheduled to be increased to 2,700 tonnes U_3O_8 by 1982 or 1983. Reasonably assured resources total about 25,000 tonnes U_3O_8.

The Akouta deposit, controlled by Compagnie Miniere d'Akouta (Cominak), began production in 1978. Reasonably assured resources at Akouta are estimated at 17,000 tonnes U_3O_8. Production in 1979 was 2,075 tonnes U_3O_8. Production capacity is planned to be increased to 2,600 tonnes U_3O_8 by 1982. The deposit occurs in the same Carboniferous formation as at Arlit.

The largest deposit in Niger is the Imouraren deposit located about 70 km south of Akouta. The Office National des Ressources Miniere, a government agency known as Onarem, reports that the orebody contains reasonably assured resources of approximately 78,000 tonnes U_3O_8, at an average grade of 0.12 percent U_3O_8. The ore zone occurs in Jurassic sandstones. Three other deposits in the same geologic environment as the Arlit and Akouta deposits are being considered for development: the Arni deposit is in the final engineering stage; the Azelik and the Madouela deposits are in the final evaluation and feasibility stages.

Reasonably assured resources in the Republic of Niger are estimated by Onarem to total 150,000 tonnes U_3O_8 in the deposits of Arlit, Akouta and Imouraren, plus approximately 15,000 tonnes U_3O_8 contained in other known deposits.

Gabon

Exploration in Gabon is at a low level and confined primarily to the district containing the Oklo and Mounana deposits. Reasonably assured resources in those two deposits are approximately 24,000 tonnes U_3O_8. Both deposits are being produced at a combined rate of 1,300 tonnes U_3O_8 annually.

Other Africa Israel

Reasonably assured resources in the Central African Empire and Algeria remain unchanged at 9,500 and 33,000 tonnes U_3O_8 respectively. The larger deposits in southern Algeria are being evaluated for mining. The Egyptian Nuclear Materials Authority recently announced the discovery of about 5,000 tonnes U_3O_8

[3]Ore grade refers to the relative quantity or percentage of uranium content of the ore.

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near Qina, on the Red Sea coast. Details on the deposit are not available. Anomalous radioactive occurrences along the Zimbabwe-Zambia border are being evaluated by Anglo-American Corporation of South Africa.

Israel has reasonably assured resources of about 36,000 tonnes U_3O_8 associated with phosphate deposits in the Dead Sea and in the Negev Desert. The uranium would be produced as a by-product of phosphoric acid production. However, there are no plans to develop the phosphate deposits in the immediate future.

ASIA

Uranium exploration and development has increased substantially throughout the Far East in the last ten years. Active exploration areas include China, Japan, Korea, Thailand, India and Pakistan. Areas of primary interest are shown in Figure 2.

China

China's interest in uranium has increased recently. Uranium occurrences have been reported in Xinjiang Uygur, Qinghai, Inner Mongolia, Liaoning, Guizhou and Guangdong provinces. Only limited information is available on uranium exploration and development activities in China. The following is taken generally from published information and through direct communication with Chinese representatives.

The Chinese report a major uranium occurrence in south China. The deposit was originally discovered in 1956, but only recently reported. The orebody is described as covering about 100 square kilometers containing over 100 rich veins of easily extracted uranium in granite strata. This implies that the deposit may be similar to the deposits in the Forez and Vendee areas of France.

Additional mineralization was discovered in northeast China in 1978. The area is reported to have a geologic setting similar to the east Alligator River region of Australia's Northern Territory. The potential of the area is being evaluated for additional uranium occurrences.

The Lianshanguan deposit, in the Liaoning province of northeast China, has potential resources of about 900 tonnes U_3O_8. The deposit is localized in quartzite and has an average grade of about 0.5 percent U_3O_8. The principal uranium mineral present is pitchblende. The Chinese report that the deposit has not been studied in detail.

The Saima deposit is located in Inner Mongolia. Mineralization has been discovered in alkaline rock, the outcrop area of which measures about 20 square kilometers on the surface. Preliminary drilling indicates that mineralization may extend to a depth of 1,000 meters. Additional evaluation will be required prior to exploiting the deposit.

Of interest also, is the fact that the Chinese say they have discovered a new secondary uranium mineral in Western Hunan province. The new mineral was named Furongite and its composition is $Al_2UO_2(PO_4)_2 \cdot 8H_2O$. The new mineral was discovered in 1974 in Lower Cambrian Carbonaceous shale. It is bright yellow in color and occurs as veinlets or irregular masses along fracture surfaces. Furongite has been found in other uranium deposits as well, usually in association with autunite.

Japan

Reasonably assured resources in Japan are about 8,200 tonnes U_3O_8. Prospecting continues in Tono, the area believed to carry the greatest potential for uranium deposits in Japan. Japan has one milling plant with a capacity of 30 tonnes U_3O_8 per year. There are no plans to construct additional commercial milling plants.

India

India has reasonably assured resources of about 18,000 tonnes U_3O_8 located primarily at the Jaduguda mine in Bihar province. The deposit was first mined in 1956. Production from the mine is 1,000 tonnes of ore per day, all of which is processed at a nearby mill. Additional ore deposits have been discovered in the crystalline rocks of the Madhya Pradesh and Rajasthan provinces of central India.

AUSTRALIA

Two political decisions made in Australia during 1979 were significant to the country's developing uranium program. First, the federal government licensed the mining and milling of the Nabarlek deposit (milling began in May 1980), and initial strip mining and mill construction was started on the Ranger One deposit. Second, the new Premier of South Australia announced that production of uranium would be permitted, after a moratorium extending over the past seven years. Areas of primary interest in Australia are shown in Figure 3.

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Figure 2
ASIA

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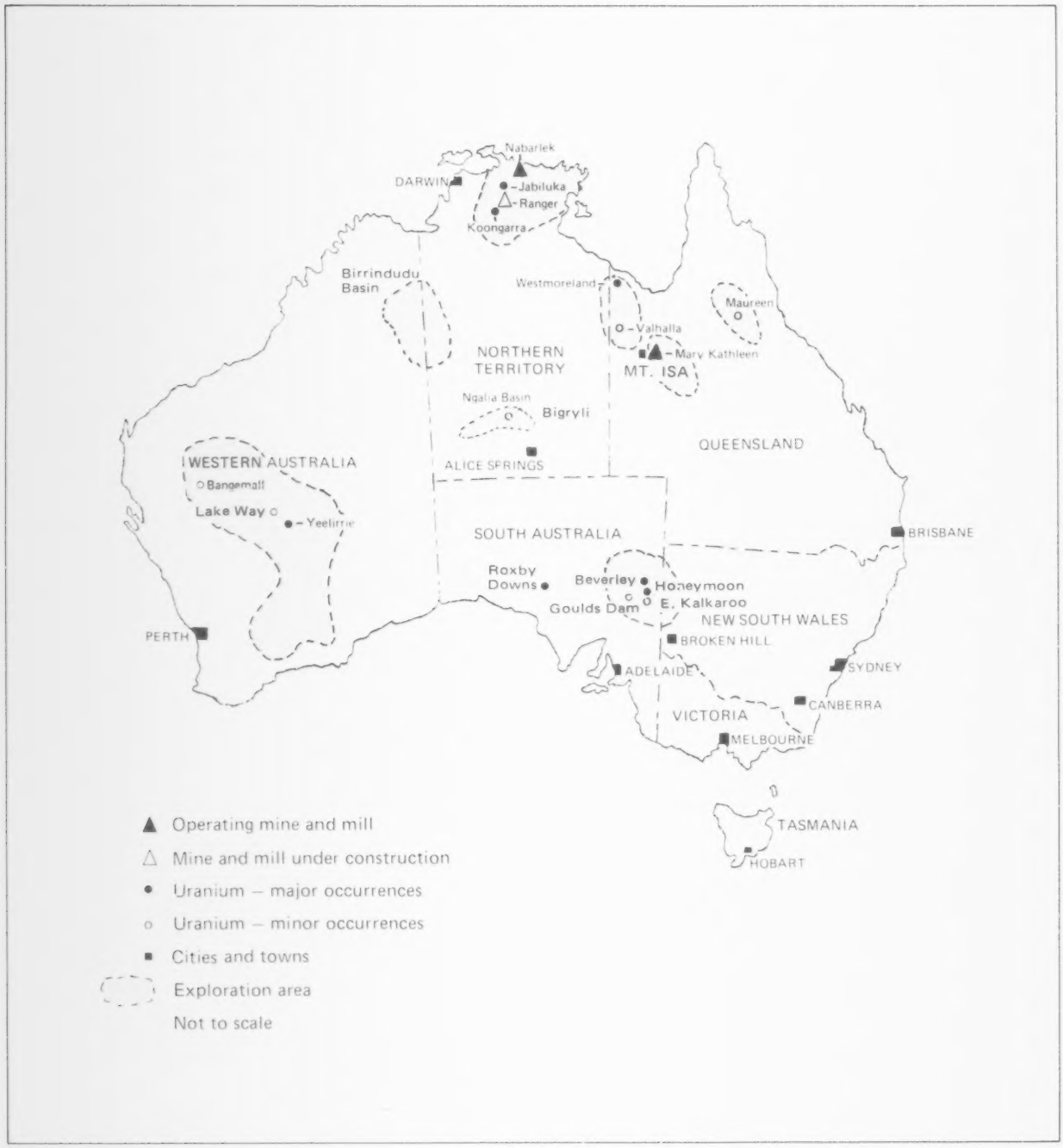

Figure 3
AUSTRALIA

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Exploration is in progress throughout the area of the Pine Creek Geosyncline—the geologic structure containing the Koongarra, Ranger, Jabiluka and Nabarlek deposits in the Northern Territory, and in northwest Queensland in the region of the Westmoreland, Valhalla, Maureen and Mary Kathleen deposits. Activities in South Australia are directed toward further evaluation of deposits in the Lake Frome Embayment and the large copper uranium deposit at Roxby Downs. Preliminary in situ leach tests on the Honeymoon deposit at Lake Frome showed favorable recovery results. Further testing is now in progress to determine the feasibility of recovering the uranium by this method, rather than conventional methods.

The Yeelirrie deposit remains the largest uranium deposit known in Western Australia. The ore minerals occur in calcrete beds of Tertiary age. Project development is tentatively scheduled to begin in 1985. Evaluation of the Lake Way deposit (also referred to as Wiluna) is still in progress. Exploration has been renewed in the Birrindudu Basin area along the border of Western Australia and the Northern Territory, where the geologic environment is similar to that of the Pine Creek Geosyncline. The potential is favorable for large, high grade deposits in the Tanami Complex of Lower Proterozoic age.

Evaluation of the Mary Kathleen, Valhalla, Westmoreland and Maureen deposits in northern Queensland is also in progress. Exploration activity has spread to include surrounding areas, where new uranium occurrences have been discovered. Additional evaluation work remains to be done in most cases; however, at the Mary Kathleen mine, new recoverable reserves have been included in the mine plan. The Mary Kathleen mine remains as the only operating uranium mine in Queensland.

Reasonably assured resources in Australia are estimated from published information at 165,200 tonnes U_3O_8. Australian resources make up about 20 percent of the world's known reasonably assured resources. Table 2 is a breakdown of Australian resources by state.

Table 2

AUSTRALIAN URANIUM DEPOSITS
REASONABLY ASSURED RESOURCES BY STATE

State Deposit	Tonnes U_3O_8	% Ore Grade	Remarks
Northern Territory			
Nabarlek	12,000	2.36	Ore mined out, mill operating
Jabiluka	208,000	0.39	Development feasibility study in progress
Ranger	111,000	0.30	Mine and mill under construction
Koongarra	30,000	0.34	Development feasibility study in progress
Bigryli	1,200	0.45	Evaluation Drilling
Queensland			
Mary Kathleen	6,000	0.11	Mine and mill operating
Valhalla	5,800	0.16	Evaluation Drilling
Westmoreland	11,500	0.17	Evaluation Drilling
Maureen	3,600	0.11	Evaluation Drilling
Western Australia			
Yeelirrie	46,300	0.15	Development feasibility study in progress
Lake Way	1,500	0.15	Development feasibility study in progress
South Australia			
Beverley	16,000	0.28	Considered for open pit and or in situ leaching
Honeymoon	3,100	0.22	In situ leach test pending
East Kalkaroo	1,100	0.15	Considered for in situ leaching
Goulds Dam	1,800	0.12	Considered for in situ leaching

Total Reasonably Assured Resources: 165,200 tonnes U_3O_8

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EUROPE

France, Spain, Portugal, Ireland, Sweden, Denmark, Italy and West Germany continue to maintain an aggressive role in the exploration for uranium resources. While much of their effort is directed toward the more favorable uranium provinces of Africa, Canada, Australia and the United States, some effort is being devoted to exploration within Europe, especially in France. Figure 1 shows the main areas of interest throughout Europe.

France

The French have assumed a leadership role in developing nuclear power, including a highly successful uranium exploration and development program. Other European countries have initiated domestic uranium programs as well, but in any case, results have been less successful than in France.

The exploration by Cogema (Compagnie Generale des Matieres Nucleaires) has resulted in another significant uranium discovery in France. Cogema recently announced the discovery of approximately 23,600 tonnes U_3O_8 in Tertiary sediments located near Contras, northeast of Bordeaux, in southwest France. Several ore deposits have been found in a roll-front environment in Eocene sediments similar to the deposits in Wyoming in the United States.

The average grade of the ore is 0.10 percent to 0.12 percent U_3O_8. The ore is shallow enough to be mined by open pit methods. The deposits occur in a broad Tertiary basin, representing a large area which is geologically favorable for additional ore occurrences. Cogema is continuing exploration of the basin area.

The new discovery increased reasonably assured resources in France to approximately 93,600 tonnes U_3O_8, up from 70,000 tonnes U_3O_8 last year. The Lodeve district of southeast France has resources of about 23,000 tonnes U_3O_8. The remaining 17,000 tonnes U_3O_8 are located in metamorphic and granitic rocks in the central Massif district of La Crouzille, Forez and Vendee. Exploration is also underway near Morvan and Vosges in northeast France.

Domestic uranium production was about 2,700 tonnes U_3O_8 in 1979. This could increase to 3,600 tonnes U_3O_8 during 1981 if present expansion programs are completed as scheduled. A timetable for development of the deposits at Contras has not been announced.

Spain

The output of uranium concentrates in Spain has levelled off at about 235 tonnes U_3O_8 per year. The main mine at Ciudad Rodrigo, in Salamanca, has an annual capacity of about 120 tonnes U_3O_8; approximately 85 tonnes U_3O_8 were produced from the Andujar mines, and 30 tonnes from the El Lobo mine.

Reasonably assured resources in spain equal about 12,500 tonnes U_3O_8. Of that amount, 11,000 tonnes occur in the Ciudad Rodrigo mine. Expansion now in progress at the Ciudad Rodrigo facility will increase annual capacity to 900 tonnes U_3O_8 by 1983.

Portugal

Portugal's reasonably assured resources are approximately 9,000 tonnes U_3O_8. The greatest geologic potential for uranium is in the vein deposits in the Hercynian granites and associated contact-metamorphic rocks. In 1979, Portugal produced 133 tonnes U_3O_8 from the Cunha Baixa, Urgeirica and Nisa mines, and at least three smaller deposits.

Sweden

The plan to recover uranium as the primary mineral from the Billingen shales, near Ranstad, has been abandoned according to an announcement by the Swedish government. However, the recovery of by-product uranium from the shales may be realized through a new plan to mine the shales for eight minerals in addition to uranium. Such a mining plan is under consideration through the joint venture effort of LKAB, the state-owned mining company, and Boliden, a large, privately owned mining company. The joint venture company ASA, is conducting research and development programs to determine the feasibility of the plan.

The only reasonably assured resources known in Sweden are located at Pleutajokk, in the northern part of the country. The deposit consists of uraninite mineralization occurring in veins and fractures associated with faulting in metavolcanics. Reasonably assured resources are about 1,200 tonnes U_3O_8. The deposit will be evaluated further before development is considered.

Primary uranium mineralization occurrences have been discovered in pegmatites and aplites throughout Sweden. None of the occurrences are considered to be exploitable; even so, the potential is high for the discovery of additional uranium resources in a number

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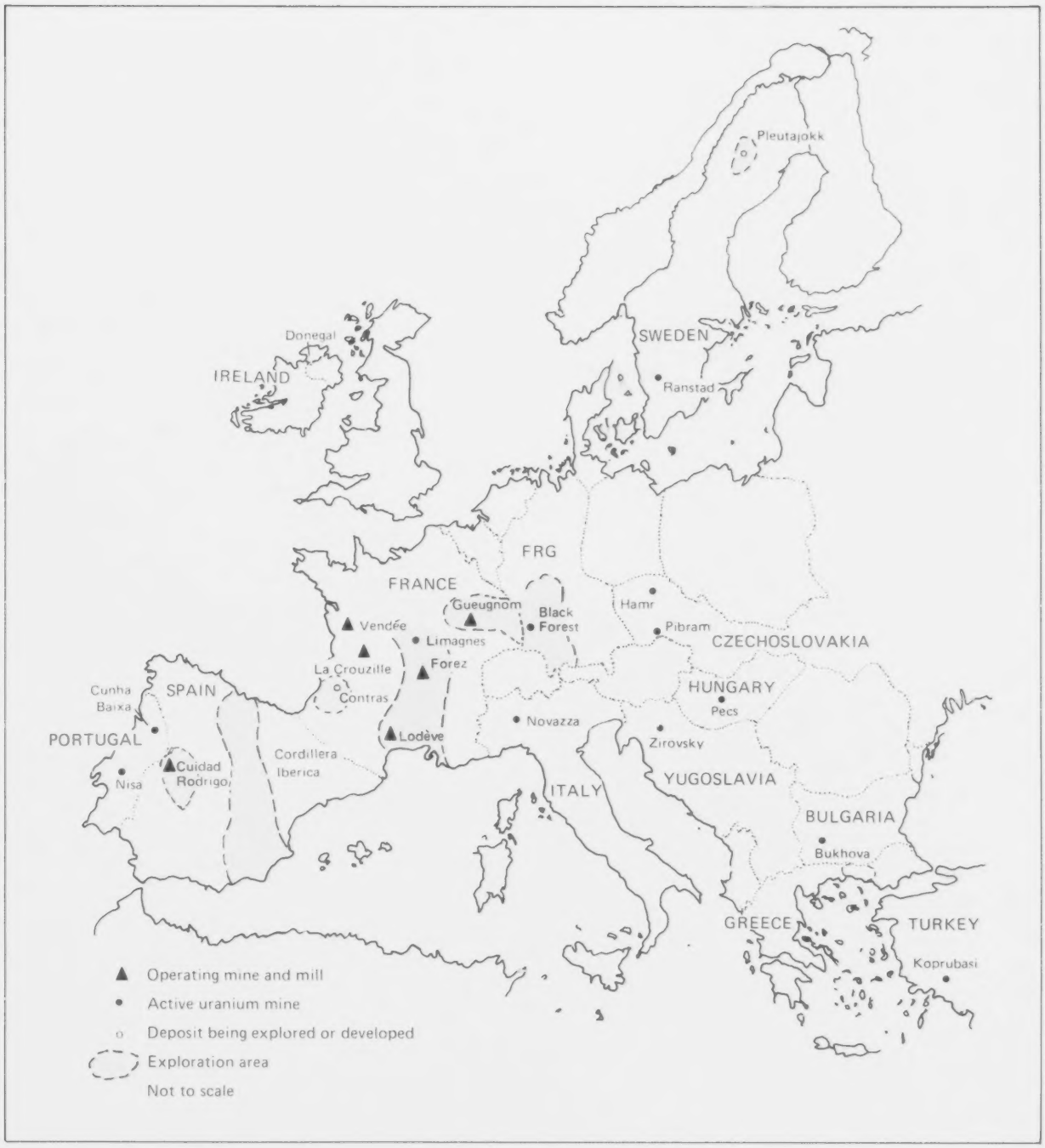

Figure 4
EUROPE

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of different geologic environments throughout the country.

Denmark

All uranium resources controlled by Denmark are located in Greenland. Exploration activity in Greenland has increased due to the availability of additional financing from the Danish government and the Commission of European Communities (EEC). Uranium exploration efforts are concentrated in the southern area near Kvanefjeld, where a low grade deposit has been found. Reasonably assured resources are about 32,000 tonnes U_3O_8. The Geological Survey of Greenland continues to evaluate the country for additional uranium resources. Southern and eastern Greenland are considered the most favorable areas.

Italy

The Novazza deposit, in the Bergamo province of northwest Italy, is the only proven uranium deposit in Italy. Reasonably assured resources are about 1,200 tonnes U_3O_8 at an average grade of 0.09 percent U_3O_8. Minor occurrences of uranium have also been found at Val Rendena, Trento province, and in the Preit Valley, Cuneo province. Agip Nuclear is exploring in each area.

Greece

Exploration activities in northern Greece are concentrated near Drama and Kavalla in the region of Macedonia. Reasonably assured resources of about 1,000 tonnes U_3O_8 have been reported in this area by the Greek Atomic Energy Commission. In Serres, uranium has been discovered in lignite. Concentrations range from 0.015 percent to 0.025 percent U_3O_8 over an area of 1.0 by 1.5 kilometers.

Other Europe

Anglo United Development Corporation has found significant uranium mineralization at its Finn uranium project in County Donegal, Ireland. Contained uranium varies form a low of 0.01 percent to a high of 0.17 percent U_3O_8. Mineralization is found along a fault structure for a distance of about 2,300 feet. Evaluation of the project area is still in progress. Other companies are exploring in the same district, and in Kilkenny and Leinster as well.

The Geological Survey of Ireland recently completed a ground radiometric survey for uranium throughout much of the country. A number of anomalous areas were recorded. Follow-up evaluation is planned for the more promising anomalies.

Exploration in the Black Forest area of the Federal Republic of Germany is continuing on a modest scale. Prospecting and drilling are in progress in the Bayerische Wald, Oberpfalz and Schwartzwald areas.

NORTH AMERICA

Important discoveries in northern Saskatchewan and the Northwest Territories of Canada keep interest high. Activities in the United States are well below 1979 levels. Decline of exploration activity in the US could be about 30 percent lower than last year. In Mexico, Uranis de Mexico (URAMEX) has renewed exploration activity in the Aldama district of Chihuahua and the Reynosa district of Tamaulipas.

Canada

Saskatchewan: Exploration in Northern Saskatchewan gained momentum again this year after the important discovery at McClean Lake by Canadian Occidental Petroleum Ltd. and Inco Metals Company. Two ore deposits have been found at McClean Lake—McClean North and McClean South. The North deposit was found early in 1979. Drilling indicated a mineral zone about 2,200 feet in length and 200 feet in width. Percentage of uranium content in the ore is between 0.25 percent and 27.8 percent U_3O_8; the average U_3O_8 grade is about 2.00 percent. The South deposit was discovered about 2,000 feet from the North deposit in early 1980. The ore zone dimensions already exceed 1,000 feet in length and 200 feet in width. The percentage of contained uranium is comparable to the North deposit. Project evaluation will probably continue for several more years to completely delineate the deposits.

Saskatchewan Mining Development Corporation (SMDC) is developing two major projects—Cluff Lake and Key Lake—and continues to participate in more than 200 exploration ventures. Exploration and development expenditures by SMDC could total as much as C$33 million in 1980.

SMDC recently acquired a 20 percent interest in the Cluff Lake project from Amok. The "D" orebody is being mined and the ore stockpiled for processing in the mill, which is under construction. Mill startup is scheduled for late 1980. Mill design capacity is about 1,200 tonnes U_3O_8 per year. Development activity at the Key Lake deposit, which is jointly held by SMDC, Uranerz Exploration & Mining Company and Eldor Resources, is presently limited to development drill-

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ing and draining of the lakes over the orebodies. Reasonably assured resources for the Key Lake deposit are about 70,000 tonnes U_3O_8, making it one of the largest uranium deposits in the world. Percentage of uranium content in the ore varies between 0.72 percent to about 33.0 percent U_3O_8 and averages 2.5 percent U_3O_8. An Environmental Impact Statement was submitted to Federal and Provincial authorities in October 1979, and a Board of Inquiry has been established to determine the conditions for development of the mine-mill facility. Construction is scheduled to be completed by 1984 or early 1985.

Drilling on the Midwest Lake deposit indicates reasonably assured resources are 23,000 tonnes U_3O_8 at an average grade of 1.25 percent U_3O_8. Current plans call for property development to begin by 1983 and initial production to start in 1986 at an annual rate of 2,000 tonnes U_3O_8.

SMDC, Asamera Oil and Gas and Kelvin Energy, in a joint venture, have discovered a second ore deposit in the northern portion of the Keefe Lake-Henday Lake exploration area. The new discovery is on Keefe Lake, about 800 meters southwest of the joint venture's Dawn Lake deposit. Mineralization at the Dawn Lake deposit occurs over a strike length of about 150 meters. Both deposits are in an early stage of evaluation. Information as to size and grade of the deposits is unavailable.

The Gulf Minerals Canada Ltd., SMDC and Noranda Exploration Company Ltd. joint venture has announced a new discovery eight miles north of the Rabbit Lake site. The new deposit is called Eagle Point. Mineralization occurs in steeply dipping rock of the Wollaston Fold Belt series to a depth of 900 feet. At this time, the known length of the mineralized zone is about 3,400 feet. Evaluation of the deposit is continuing.

In summary, there are at least 16 important ore deposits in northern Saskatchewan, plus a number of favorable indications of mineralization, which remain to be evaluated. The locations of the deposits are shown in Figure 5. Reasonably assured resources are estimated at about 140,000 tonnes U_3O_8 for the district.

Ontario: The major producing area in Canada is Elliot Lake, in Ontario. Uranium occurs within two large mineralized belts known as the Quirke and Nordic ore zones. Rio Algom and Denison Mines Ltd. control most properties on the two ore zones. Rio Algom has expanded operations at its Quirke and Panel mines to 9,350 tonnes ore per day to meet contractual commitments. The Stanleigh mine will be reopened to increase production capacity another 1,535 tonnes ore per day by 1984. The average percentage of uranium content in the ore is between 0.10 percent U_3O_8 and 0.125 percent U_3O_8.

Denison Mines Ltd. is expanding capacity at the Elliot Lake mill to 13,610 tonnes ore per day. Expansion work will be completed in late 1980. In addition, Denison plans to reopen the Stanrock property, with mining scheduled to begin by 1985.

Rare Earth Resources Ltd. plans to reopen its Halo property in eastern Ontario. Uranium resources at the Halo mine are estimated at 136,000 tonnes ore at an average grade of 0.06 percent U_3O_8. Rare Earth Resources and Esso Minerals Canada are also considering the exploitation of three new deposits in the Bancroft area.

British Columbia: The Social Credit Government of British Columbia has declared a seven-year moratorium on uranium exploration and mining, citing environmental factors as reasons. The net effect of the moratorium is that rights to uranium mining will not be issued. This kills an important sector of the British Columbian mining industry and wipes out a lucrative sales contract for the development of the Blizzard Lake ore deposit near Beaverdell.

Nova Scotia: Uranium exploration activity has declined over the last year in Nova Scotia. Large land tracts have been dropped and activities are being limited to specific targets in the sandstone of the Upper Carboniferous Pictou group, the Lower Carboniferous Windsor group and granitic rocks of Devonian age.

Newfoundland Labrador: Northgate Exploration Ltd., Westfield Minerals and Shell Canada Resources Ltd., in a joint venture, are exploring uranium prospects in the Carboniferous group near the Deer Lake-Codroy Valley areas of Newfoundland. Brinco's Kitts-Michelin uranium deposits near Makkovik, in Labrador, are found in Precambrian volcanic rocks. The uranium content of the ore varies between .12 percent and .57 percent U_3O_8. Reasonably assured resources total 9,000 tonnes U_3O_8.

Northwest Territories: A major drilling program is to be carried out by Kelvin Energy in the Nonacho

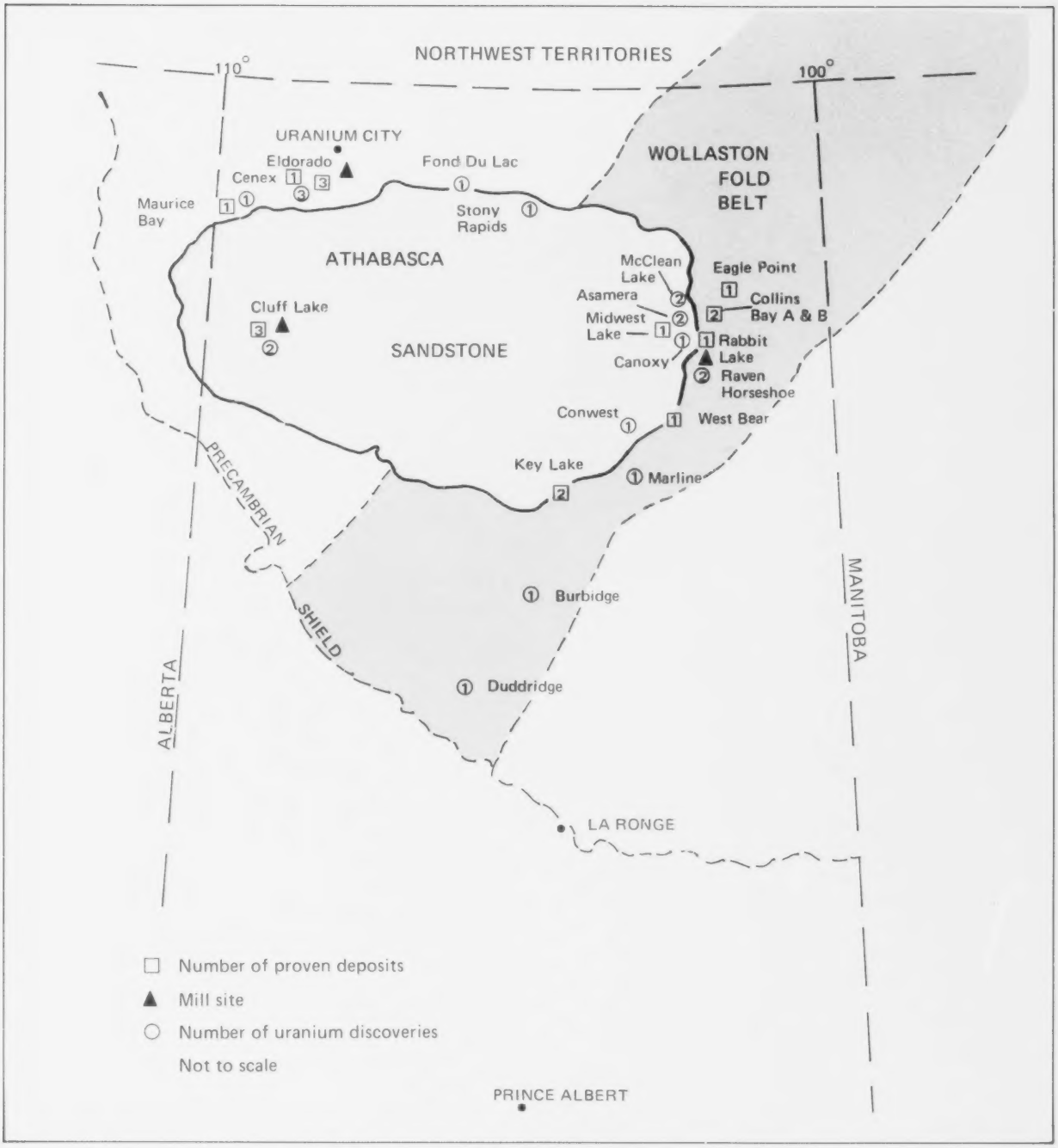

Figure 5
NORTHERN SASKATCHEWAN

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Basin near Louison and Heron Lakes in the Northwest Territories, where four new uranium deposits have been discovered. Percentage of uranium content in the ore is between 0.042 percent and 32.22 percent U_3O_8 with an average grade of more than 1.5 percent U_3O_8. These four deposits represent the first important uranium to be discovered in that part of the Northwest Territories. Other areas of interest include Baker Lake where Pan Ocean and Urangesellschaft mbH & Co. have made important discoveries, and Great Slave Lake and Great Bear Lake. Principal uranium exploration areas and the important deposits in Canada are shown in Figure 6.

Resources: The Uranium Resource Appraisal Group of the Department of Energy, Mines and Resources has estimated reasonably assured resources for Canada at about 295,000 tonnes U_3O_8, of which at least 140,000 tonnes U_3O_8 are located in northern Saskatchewan. The remaining 139,000 tonnes U_3O_8 make up the resources for the rest of Canada.

United States

The United States Department of Energy reported 1979 exploration expenditures by the domestic uranium industry at about US$316 million, an increase of US$2 million over 1978 expenditures. However, exploration and development drilling was 11 million feet in 1979, down from 17 million feet in 1978. The cost variance is largely due to inflation. Reasonably assured resources increased from 835,000 tonnes U_3O_8 in 1978 to 850,000 tonnes in 1979—an increase of about 15,000 tonnes U_3O_8. Figure 7 shows the principal uranium resource areas of the U.S.

Wyoming: The highlight of the year was the announcement by The Anaconda Company of the discovery of a deposit containing 18,000 tonnes U_3O_8 on its Green Mountain property, south of Jeffery City, Wyoming. The property is controlled by Anaconda (50%), Pioneer Nuclear Inc. (25%) and Texas Eastern Nuclear, Inc. (25%). Plans to develop the property by 1985 are under consideration.

Mine and mill construction continue at the Red Desert properties held by Minerals Exploration Company. Production is scheduled to begin at the 2,700 tonnes per day complex by year end. In the Gas Hills, Pathfinder Mines Corporation has expanded its mill capacity to 2,500 tonnes per day to handle ore from the Eagle Mine located southeast of Crooks Gap. There are six in situ leach production centers in the Powder River Basin. Two are operated by Rocky Mountain Energy and one each by Cleveland Cliffs, Wyoming Mineral Corporation, Teton Nerco and Exxon Minerals, USA. Figure 8 shows the main areas of uranium activity in Wyoming.

New Mexico: The Mount Taylor project of Gulf Mineral Resources Company in McKinley County, New Mexico, is in the early stage of mine development and ore is being produced on a limited basis. The ore grade is at least 0.25 percent U_3O_8; reasonably assured resources are approximately 45,000 tonnes U_3O_8.

Phillips Uranium Corporation is developing three shafts at Nose Rock. Two shafts are at a depth below 3,000 feet—total depth will be about 3,200 feet (work on the third shaft was recently terminated). Conoco Inc. and Wyoming Mineral Corporation are performing development work on a deposit at Crownpoint. The first access shaft is presently being drilled to a depth of 2,250 feet. The ore depth is about 2,100 feet. Exploration is still concentrated in the known districts of New Mexico, but interest is spreading to new areas such as the Costilla Mountains near Taos. Figure 9 shows the location of mines and mills in the Grants uranium belt.

Utah: New deposits are being developed near La Sal in the southwest area of the Colorado Plateau by Union Carbide Corporation and Atlas Corporation. Atlas is now mining from its Velvet property—a high grade deposit in Lisbon Valley. The Dirty Devil River district of southeast Utah is the recent scene of renewed exploratory drilling by Cotter Corporation. Initial drilling results indicate important mineralization at a depth of 1,600-1,700 feet. Energy Fuels Ltd. began production in May at its mill located near Blanding. Capacity is 1,700 tonnes ore per day. Plateau Resources plans to complete construction of a mine and mill complex on Ticaboo Mesa in 1981. Planned capacity is 900 tonnes ore per day.

Arizona: In Arizona, Anamax Mining, a joint venture between the Anaconda Company and Amax Corporation, is producing uranium as a by-product at its Twin Buttes copper mine and milling complex in Sahurita, south of Tucson. The first shipment of concentrates was made in April, 1980. Uranium production is expected to be about 64 tonnes U_3O_8 per year.

Colorado: Amoco Minerals Corporation, formerly

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Figure 6
URANIUM DEPOSITS AND EXPLORATION AREAS IN CANADA

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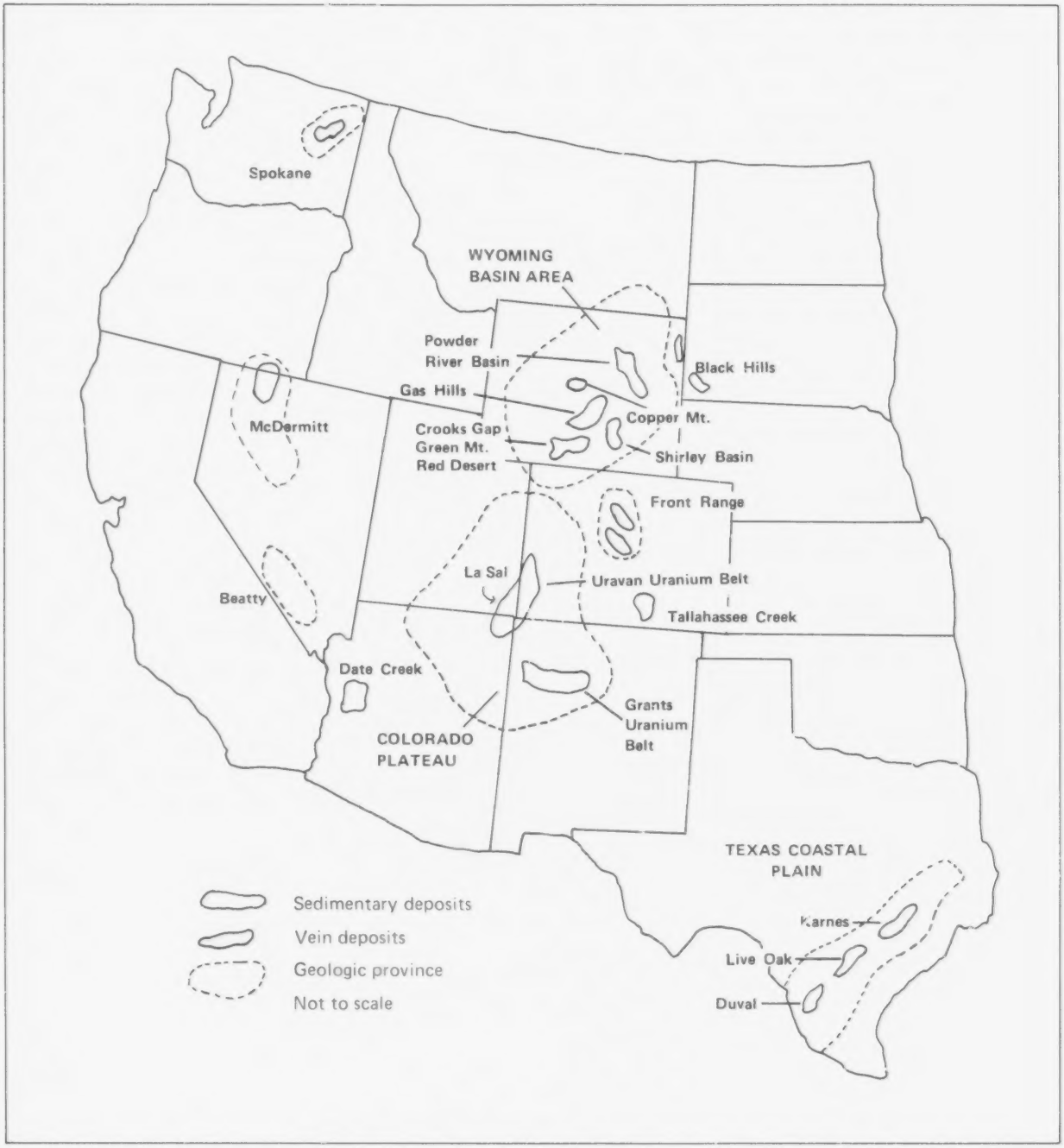

Figure 7
PRINCIPAL URANIUM RESOURCE AREAS OF THE UNITED STATES

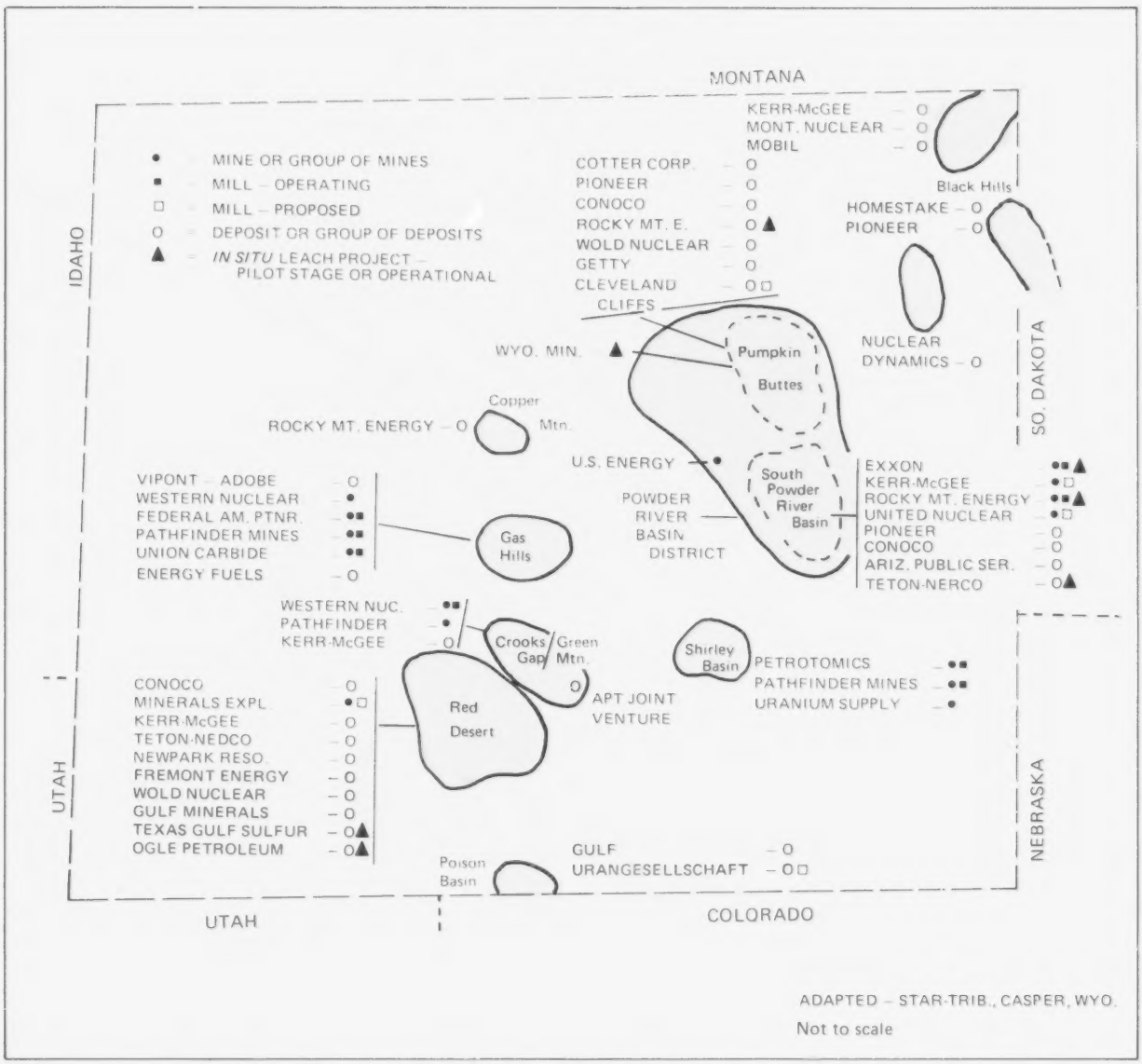

Figure 8
PRINCIPAL URANIUM DISTRICTS OF WYOMING SHOWING PARTIAL LIST OF COMPANY ACTIVITY

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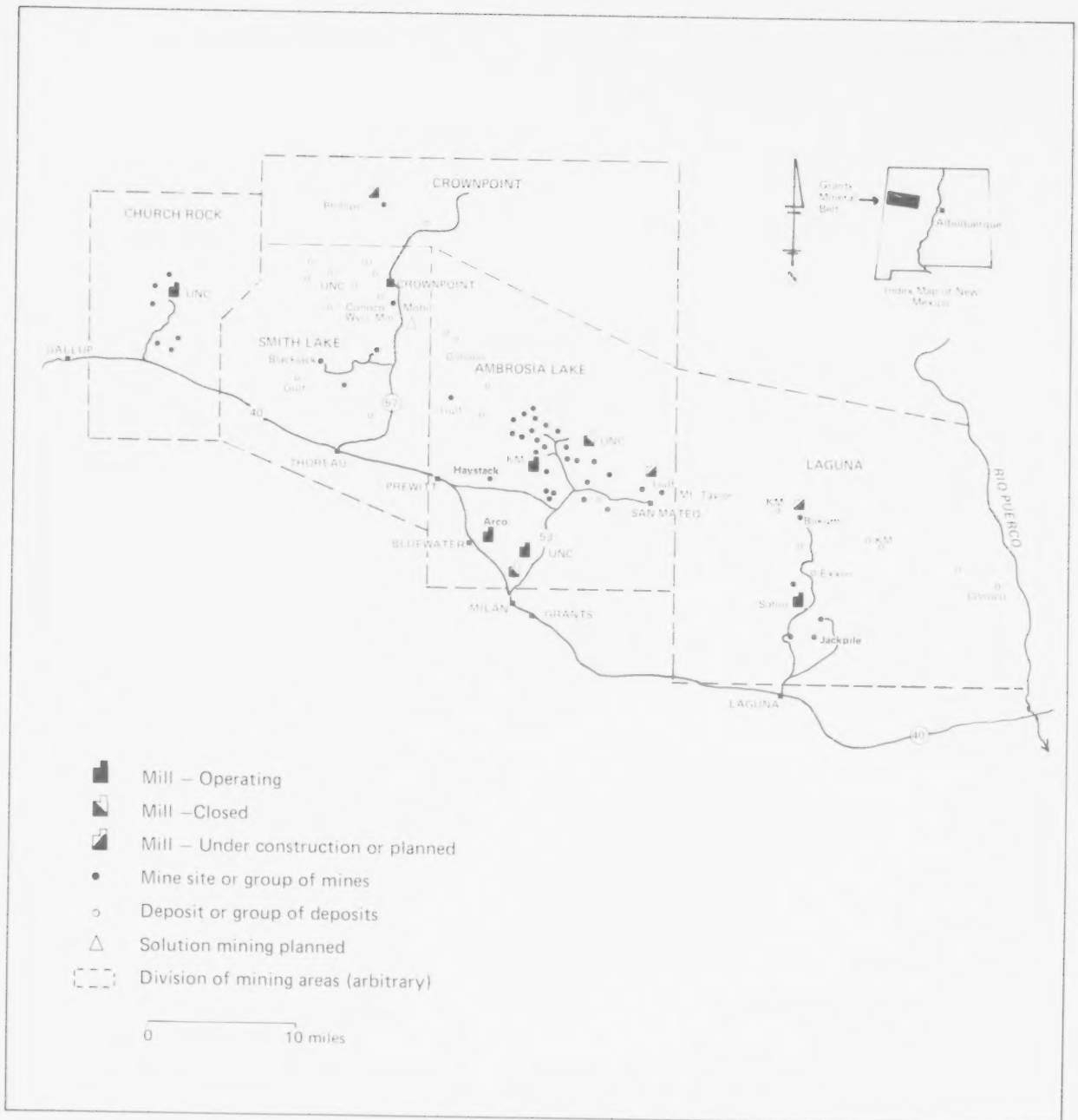

Figure 9
URANIUM DEPOSITS, MINES AND MILLS
IN THE GRANTS URANIUM BELT, NEW MEXICO

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Cyprus Mines Corporation, and Wyoming Mineral Corporation have postponed development of the Hansen deposit in the Tallahassee Creek area northwest of Canon City for at least two years. Homestake Mining Company began mining at its Marshall Pass property at a rate of 550 tonnes of ore per month. Homestake is continuing its efforts to obtain permits for the construction and operation of a mill. Planned mill capacity is 1,100 tonnes per day.

Nevada: Placer Amax Inc. has identified a deposit containing about 6,500 tonnes U_3O_8 at its McDermitt property in the north central part of Nevada. Mineralization occurs in a large Tertiary caldera structure. Caldera structures and Tertiary formations in Nevada are being investigated for uranium mineralization by a number of companies as a result of the exploration success at McDermitt. Uranium occurrences are known in the Beatty Caldera (see Figure 7).

Texas: Exploration and development activity in Texas is continuing at a high level, due primarily to favorable actions by state regulatory agencies toward new property development. There are 13 in situ leach plants operating in the Coastal Plain district of Texas with an estimated production capacity of about 2,500 tonnes U_3O_8 annually. Five plants under construction are scheduled for completion by the end of the year. The five plants will increase annual production capacity by another 635 tonnes U_3O_8. However, present rate of production is about 1,350 tonnes U_3O_8 per year.

Conoco Inc. plans to strip mine about 91,000 tonnes ore from its Tom-Retzloff leases in Atascosa County, in south Texas. Excavation depths will average 116 feet over the 54 acre site. The Anaconda Company has applied for approval to mine a 570,000 tonne deposit on the Rhode Ranch site in McMullen County. The proposal would permit Anaconda to mine the deposit over a 10-year period.

Florida: The phosphate deposits in the southeastern United States contain about 12 billion tonnes of potentially minable phosphorite resources. The deposits in the central and southern areas of Florida, contain about 1.8 billion tonnes of minable phosphate which contains about 200,000 tonnes U_3O_8 at an average grade of .015 percent U_3O_8. Uranium is being recovered as a by-product to phosphoric acid at three uranium recovery plants now operating in central Florida and one plant in Louisiana. Annual recovery capacity is about 1,050 tonnes U_3O_8. Three plants under construction will increase capacity by 730 tonnes U_3O_8 per year by 1982.

Other: In Washington State, 25,000 acres of the Spokane Indian Reservation is planned to be explored for uranium by Minatome Corporation. A dozen or more companies are actively exploring the favorable areas of the district. Dawn Mining Company is stripping another ore zone at the Midnight mine. The Dawn mill at Ford is operating at a capacity of 365 tonnes per day. Western Nuclear Inc. is operating the Sherwood mine and mill at a rate of 1,825 tonnes per day.

Drilling by Standard Metals Corporation at Alaska's Kendrick Bay indicates reasonably assured resources at 330,000 tonnes of ore with an average grade of 0.17 percent U_3O_8. So far, about 250 holes have been drilled.

Exploration activities in the U.S. decreased about 13 percent in 1979 below the previous year according to USDOE. However, for the first half of 1980, the decrease in activity was 37 percent below the 1979 level. The decrease clearly reflects a reaction by exploration groups to sharply falling U_3O_8 prices.

The annual decrease in exploration activity shows a correlation with the market value for U_3O_8 concentrates. Figure 10 is a graphic comparison of drill footage, Nuexco's Exchange Value for the period 1973 through August 1980 and annual expenditures for exploration drilling operations. The graph illustrates a lag in response time by exploration groups to changes in the market. As the Exchange Value increased and then stabilized during the 1974-1979 period, the lag in reaction time by exploration groups was about one year.

Since early 1980, the lag time has decreased considerably. The Nuexco Exchange Value has decreased by 30 percent since January; drill activity for the period of January through June 1980 is down 37 percent from the same period in 1979, and drill expenditures for January through June 1980 are estimated at 31 percent below the same period in 1979. When the Exchange Value began its sharp decline in early March 1980, exploration was quickly curtailed as the first means to control expenditures. The declining trend in exploration is presently gaining momentum, primarily among smaller exploration groups. Delays and cancellations of developing projects have taken a serious downward turn as well.

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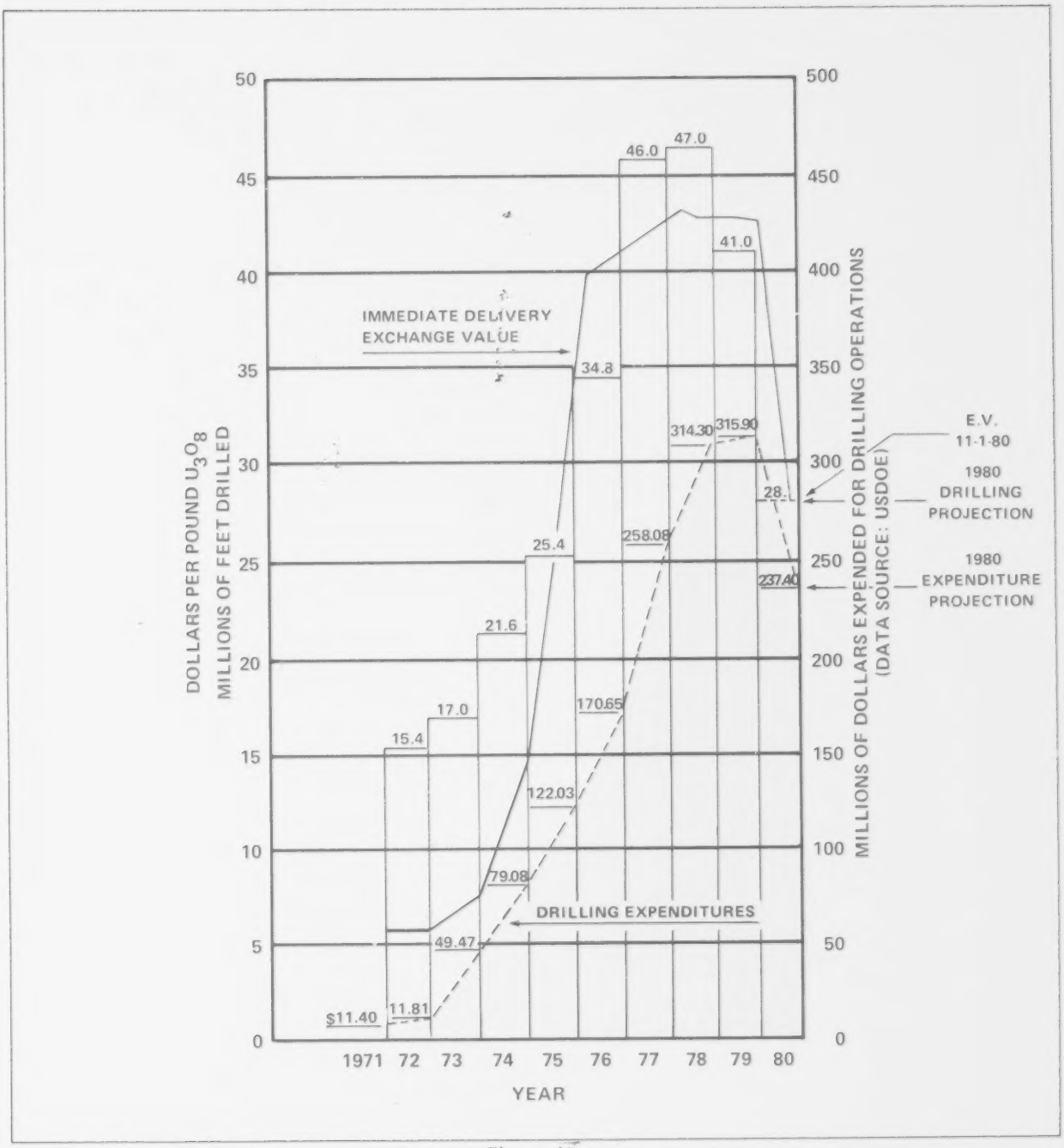

Figure 10

GRAPHIC COMPARISON—DRILL FOOTAGE, NUEXCO EXCHANGE VALUE AND ANNUAL EXPLORATION EXPENDITURES FOR THE U.S.

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Mexico

Exploration activity has only recently resumed in Mexico under the direct guidance of Uranio de Mexico (URAMEX), a division of the Ministry of National Ownership and Industrial Development. Reasonably assured resources in Mexico remain unchanged at about 7,600 tonnes U_3O_8. URAMEX is exploring in the Aldama district of Chihuahua and along the prominent ore trend in the Reynosa area of Tamaulipas—the same ore trend that extends for several hundred miles through south Texas.

URAMEX has not announced a program to develop ore deposits in either district. However, URAMEX is considering the replacement of the processing mill located near Aldama, which is not operating, with an entirely new facility located near El Sauz. The capacity and completion date of the mill have not been announced by URAMEX. Areas of interest are shown on Figure 11.

SOUTH AMERICA

Uranium exploration and development activities have increased in a number of South American countries. Uranium occurrences have been discovered through the application of preliminary exploration techniques in Bolivia, Colombia, Peru, Ecuador, Venezuela, Uruguay and Chile. Important discoveries have been made in Argentina and Brazil, with ore deposits in both countries being developed. The location of known deposits and mill sites is shown in Figure 11.

Argentina

The most important uranium deposits in Argentina occur in Jurassic and Cretaceous sediments in Mendoza province. However, additional deposits and prospects are known to occur in sediments in Jujuy and Salta provinces as well. Vein deposits and disseminated mineralization have been found in Precambrian rocks in the provinces of Cordoba, La Rioja and Neuquen.

The largest deposits now under development are located in the Sierra Pintada district of Mendoza. At least 12 minable deposits are known to occur in Jurassic sediments in the district. Reasonably assured resources are estimated to exceed 16,000 tonnes U_3O_8 in all deposits; however, the Tigre I and III deposits contain about 15,000 tonnes of the total. Mining is in progress at the Tigre I and III deposits, as well as small satellite deposits, at a rate of about 50 tonnes U_3O_8 per year. The ore is trucked to a processing mill in the Malargue district, located 180 kilometers to the south. A number of small deposits are being explored and developed in the Malargue district as well. The uranium mineralization occurs in a geologic environment similar to that at Sierra Pintada.

Approximately 30 tonnes U_3O_8 are produced annually at the Don Otto mine and mill in Salta province; the uranium is mined from Cretaceous rocks. Another 25 tonnes U_3O_8 are mined from crystalline rocks at the Rudolfo and Los Gigantes deposits and milled at Cosquin, in Cordoba province. In southern Argentina, 35 tonnes U_3O_8 per year are being produced at the Los Adobes mine and mill in Chubut province.

Reasonably assured resources in Argentina are estimated by the National Atomic Energy Commission (CNEA) at about 28,000 tonnes U_3O_8 compared to 21,000 tonnes in 1978. U_3O_8 production was about 140 tonnes in 1979. Plans to expand production capacity to at least 400 tonnes U_3O_8 are under consideration. In fact, the additional capacity could be available as early as 1983.

A new mining law was passed on July 1, 1980. It grants the CNEA the authority to establish exclusive uranium prospecting areas and regulate exports of nuclear material. In this new role, CNEA is currently considering loaning 240 tonnes of uranium concentrate (yellowcake) to Nuclebras—the Brazilian nuclear company.

Brazil

Uranium exploration and development activity in Brazil is directed by Nuclebras, either independently or in a joint venture with Urangesellschaft mbH & Co. of West Germany. The Itataia deposit in Ceara state is the largest in Brazil with reasonably assured resources of about 75,000 tonnes U_3O_8. The deposit is still being evaluated. The Pocos de Caldas deposit in Minas Gerais contains an estimated 20,000 tonnes U_3O_8. It is under development and could be in production at a rate of 150 tonnes U_3O_8 per year by early 1981. It will be the first production center in Brazil.

Reasonably assured resources of the Figueira deposit in Parana state are about 6,000 tonnes U_3O_8. The deposit appears to be a typical roll-front occurrence in Paleochannel sands. Development of the deposit is under consideration. The potential for

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Figure 11
URANIUM DEPOSITS AND OCCURRENCES IN LATIN AMERICA

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additional resources at the deposit is excellent. An additional 14,000 tonnes U_3O_8 occur in the Espinharas, Campos Belos, Lagoa Real, Amorinopolis and Quadilatero Ferrifero deposits in eastern Brazil.

Nuclebras estimates Brazil's reasonably assured resources at 115,000 tonnes U_3O_8.

Bolivia

Bolivia's first uranium mine and mill will soon begin limited production at an annual rate of four tonnes U_3O_8 at the Cotage Mine in south Bolivia. A number of uranium occurrences have been identified in Tertiary volcanic rocks of the Cordillera de Los Frailes range. The Bolivian Nuclear Energy Commission (COBOEN) directs all exploration and production activity. The main area of interest is the sedimentary basins of southern Bolivia, where COBOEN and AGIP Uranium of Italy are exploring under the conditions of a joint venture.

Colombia

A government agency, Compania Colombiana de Uranio (COLURANIO) directs all uranium exploration. Future development of uranium deposits will be controlled by the Instituto de Asuntos Nucleares (I.A.N.). Exploration joint ventures are in progress with Enusa of Spain and Power Reactor and Nuclear Fuels Development Corporation of Japan. The foreign partners can earn a 49 percent interest in all discoveries by committing 100 percent of exploration expenditures.

RESOURCE SUMMARY

The uranium resources of the Free World are tabulated in Table 3. Total resources are subject to constant change as exploration and production results are confirmed. The summary is based on public sources, superseded by Nuexco estimates where appropriate.

Table 3

SUMMARY OF WORLD URANIUM RESOURCES
Reasonably assured at US$50.00 or less per pound U_3O_8

Country	Tonnes U_3O_8	Totals
AFRICA:		
South Africa	452,000	
Namibia	104,000	
Niger	195,000	
Algeria	33,000	
Gabon	24,000	
Israel	36,000	
Central African Empire	9,500	
Egypt	5,000	
		858,500
ASIA:		
Japan	8,200	
India	30,000	
		38,200
AUSTRALIA:		465,200
EUROPE:		
France	93,600	
Spain	12,500	
Portugal	9,000	
Sweden	1,200	
Greenland (Denmark)	32,000	
Italy	1,200	
Greece	1,000	
Yugoslavia	8,000	
		158,500
NORTH AMERICA:		
Canada	279,000	
United States	850,000	
Mexico	7,600	
		1,136,600
SOUTH AMERICA:		
Argentina	28,000	
Brazil	115,000	
		143,000
TOTAL REASONABLY ASSURED URANIUM RESOURCES:		2,800,000

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